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EVALUATION OF THE ATMOSPHERIC AEROSOL PARTICLE SIZE IN THE REFLECTIVE LAYER PRODUCED BY STRONG SOLAR FLARES

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ABSTRACT

It is well known, that nowadays one of the actual problem in the troposphere investigation is to connect solar activity with meteorological processes in the troposphere. But to present day there is no model, which explains all problem of solar terrestrial links. Investigation of influence of variation solar and cosmic rays on condition in the low and middle atmosphere take a significant part in determination parameters of this model. Experimental measurements of the low and middle atmosphere temperature profile [1] show, that it was changed after strong solar flares (Fig. 1). Theoretical model proposed in [1] explains this phenomena using atmospheric absorbent or reflective layer, with heights from 5 till 20 km. Good agreement between experimental data and numerical simulation was achieved for layers with 14-16 and 8-9 km height respectively, and coefficient of transparency about 90%.

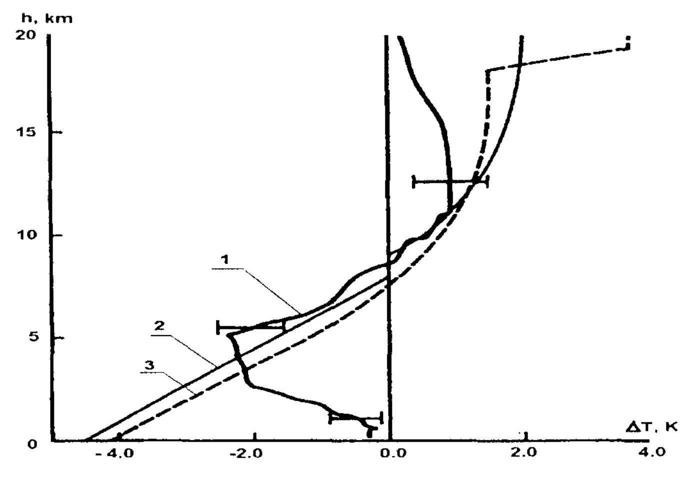

Fig. 1 Variation of temperature profile: 1- experiment, 2 – model with reflective layer on height 8-9 km., 3 – model with absorption layer on height 14-16 km.

INTRODUCTION

Lets consider a model with reflective layer as more preferable. This layer may consist of macromolecular complexes witch include both atmospheric gases ions and water. Lets assume, that aerosols concentration proportional to ion's concentration on this height.

During strong solar flare this concentration may increase from 100 cm^{-3} to 1000 cm^{-3} [2], so aerosol concentration increase too. It is well known, that about 97% of solar energy located in the wave-length of $0.2\text{-}3{*}10^{-6}$ m. (Fig. 2) [3] and this energy is stable in time, so, we have considered the aerosol influence of on transmission of electromagnetic energy only in this wave-length range.

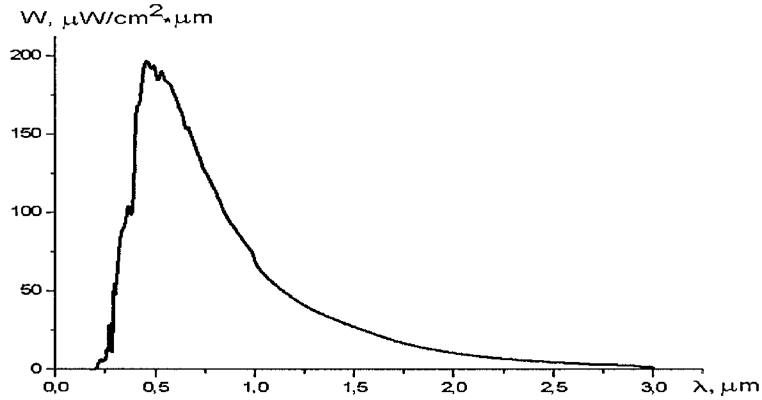

Fig. 2 W(λ) – Solar radiation density.

As a result of small water permittivity imaginary part value of [4] we have examined only mechanism of backscattering from the little drops and didn't evaluate absorption of electromagnetic energy in water drops.

EVALUATION OF THE ATMOSPHERIC AEROSOL PARTICLE SIZE IN THE REFLECTIVE LAYER

It is well known, that the atmospheric aerosol particle size lies in wide range so, we have to calculate electromagnetic scattering on aerosols using Mie equation:

$$K_{bs}(m,x)=\frac{2}{\pi^2}\sum_{n=1}^{\infty}(2n+1)(|a_n|^2+|b_n|^2), \tag{1}$$

where:

$$x=\frac{2\pi r}{\lambda}, \tag{2}$$

$$a_n=\frac{A_n(mx)\psi_n(x)-m\psi_n'(x)}{A_n(mx)\xi_n(x)-m\xi_n'(x)};b_n=\frac{mA_n(mx)\psi_n(x)-\psi_n'(x)}{mA_n(mx)\xi_n(x)-\xi_n'(x)}, \tag{3}$$

$$\psi_n(x)=\sqrt{\frac{\pi x}{2}}J_{n+\frac{1}{2}}(x), \tag{4}$$

$$\xi_n(x)=\sqrt{\frac{\pi x}{2}}[J_{n+\frac{1}{2}}(x)+(-1)^n iJ_{-n-\frac{1}{2}}(x)], \tag{5}$$

$$A_n(mx)=\frac{\psi_n'(mx)}{\psi(mx)}, \tag{6}$$

Where $J_{n+1/2}$ and $J_{-n-1/2}$ are Bessel function; $m=\nu-i\chi=1.322-i0.00001$ is complex water permittivity in wave-length range $0.2\text{-}3*10^{-6}$ m. [4].
To calculate Mie coefficients a_n and b_n (3,6) we have used Deirmenjian algorithm [4,5].
Weakening factor (dB/km) was defined by Buger low:

$$K_{scat}(x,m)=1.346439*10^{-2}\int_{R_1}^{R_2} r^2 Nf(r)K_{bs}(x,m)dr\,, \tag{7}$$

where, N is concentration of aerosols, cm^{-3}; r is radius of drops, μm; $f(r)$ is distribution density of drops size.
For simplicity sake lets assume, that radius of drops is a constant, due to similarity of the physical conditions for their appearance. Integral coefficient of transparency in wave-length range $0.2\text{-}3*10^{-6}$:

$$W(r)=\frac{1}{W_0}\int_{\lambda_1}^{\lambda_2} K_{scat}(\frac{2\pi r}{\lambda})W(\lambda)d\lambda\,, \tag{8}$$

where W_0 is the solar constant (W_0=1373±20 W/m^2 [3]).
Calculation results for reflective layer with thickness 1 km are present in Fig. 3. As shown, supposed aerosol particle radius (0.2μm, approximately) don't conflict with physical nature water aerosols.

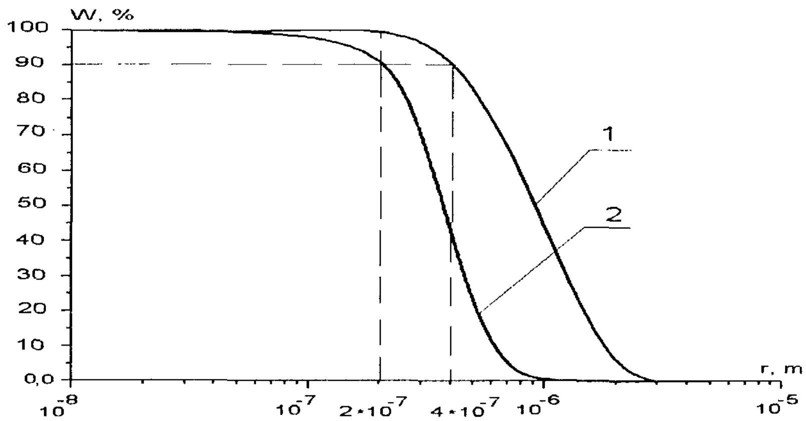

Fig.3 Coefficient of transparency; 1-for layer with N=100; 2 - for layer with N=1000;

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